

# Methods and Apparatus for Accessing Synchronized Broadcast Data

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## CROSS-REFERENCE TO RELATED APPLICATIONS

5        This application claims the benefit of: (i) U.S. Provisional Patent Application No. 60/172,694, filed December 10, 1999, and entitled "METHODS AND APPARATUS FOR ACCESSING SYNCHRONIZED BROADCAST DATA", and which is hereby incorporated by reference herein.

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## BACKGROUND OF THE INVENTION

### **1. Field of the Invention**

20        The present invention generally relates to broadcast systems. More particularly, the present invention provides methods and apparatus for accessing synchronized data transmitted by a broadcaster in a broadcast system.

### **2. Description of the Related Art**

25        In a conventional broadcasting system, a broadcaster transmits information in the form of audio, video, data, etc. over a medium such as air, cable, phone line (DSL, for example) that, in turn, can be received by any number of receivers. For example, transmitted radio waves can be received with a radio receiver tuned to a particular transmission channel. Using this

conventional arrangement, typical broadcast communication is generally a one way medium since the receiver does not have control over the content nor the time of the broadcast transmission.

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In a digital broadcast system, data can be transmitted in the form of data packets. One such data packet form is defined by the Encapsulated IP datagrams protocol, or by Streaming data in MPEG-2 Packetized Elementary Stream (PES). In the latter case, the transmitted data packets also have associated with them  
10 timing information indicating when a particular data packet is to be processed. For example, a Presentation Time Stamp (PTS) can be included in a data packet having a value indicating the time at which a unit of data is to be processed (presented). Such PTS values can be defined relative to a System Time Clock (STC), for example, as defined by ISO/IEC 13818-1.

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Data packets could have both internal and external timing requirements. For example, in the MPEG-2 Packetized Elementary Stream (PES) protocol, external timing requirements typically imply that data from one stream must be synchronized with another stream of data. Transmitted broadcast data containing any type of timing information indicating when data should be  
20 processed is referred to herein as "synchronized data". Any type of timing information included in a data packet is referred to herein as a "time stamp".

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Fig. 1 illustrates synchronized data packets 102-106 transmitted by a broadcaster (not shown). Each of the data packets 102-106 has an associated data segment D1 through D3 respectively, as well as an associated time stamp T1 through T3, respectively. For example, data packet 102 has the time stamp T1 indicating when to process the corresponding data segment D1. During a typical broadcast session, the synchronized data packets 102-106 are received by the digital T.V. receiver at a point of service through what is referred to as a broadcast channel.

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As illustrated in Fig.1, a broadcast channel 2 is subdivided into Video subchannel (V), an Audio subchannel (A), and two Data subchannels (Da and Db). A synchronized data packet with video, audio, data information, or any

combination thereof, can be transmitted by the broadcaster through the appropriate sub-channel(s) and can be received by a receiver, such as a digital T.V. or analog T.V. with a proper decoder set-top box tuned to the particular broadcast channel. When the receiver is a digital T.V., circuitry within the digital T.V. processes the data portion of a data packet as well as the audio and video information (if present) transmitted in the respective subchannels based upon the corresponding time stamp. For example, processing the data packet 102 having video information (D1) requires the T.V. receiver to process the video data in such a way that the corresponding video image is displayed on a monitor coupled to the T.V. receiver during a time interval based upon the associated time stamp (T1). Thus, a T.V. receiver tuned to a particular channel must also access the associated synchronized data packet D1 and process the data included in the packet D1 all within the time constraints dictated by the time stamp T1.

In a similar manner, data is transmitted in a synchronized data packet on a data subchannel such as Da and Db. In many applications, such as interactive T.V., during what is referred to as synchronized processing, one must be able to process the data included in a data packet according to the time constraint indicated by the time stamp. For example, in applications such as interactive T.V., data can be processed by an interactive application program that is running on the digital T.V. and presented with audio and video in a synchronized manner.

Unfortunately, with conventional models, accessing and processing of synchronized data is problematic. This is partly attributed to the fact that a receiver does not have control over the time and the amount of data that can be transmitted by the broadcaster. To elaborate, FIG. 2 illustrates a conventional T.V. receiver 200. A tuner 204 included in the T.V. receiver 200 is tuned to a desired broadcast channel and receives the broadcast information transmitted on that channel. A demultiplexer 204 is used to divide the broadcast information into subchannels video (V), audio (A), data (D)a, and data (D)b. In this arrangement, synchronized data packets are received by the receiver 200 via a data subchannel, such as subchannel Da.

Typically, data packets are received as a single stream of data. For example, data packets 102-104 are stored in a buffer 208. Typically, the receiver 200 checks the buffer 208 to determine whether data is available for processing. In conventional models, the receiver 200 starts accessing data from the buffer 208 and sequentially accesses data packets 102, 104, and 106 in the order that they are received. To elaborate, the receiver 200 accesses synchronized data D1 of data packet 102 and processes it during a time interval defined by the time stamp T1. However, in some situations, data is transmitted at a higher rate than the receiver 200 can process it, in which case it is possible that the receiver 200 falls behind in processing. For example, while the receiver 200 is processing synchronized data packet 104, it is possible the time stamp T3 for processing and presentation of synchronized data packet 106 expires. Thus, the receiver 200 would be unable to process and present data in a timely manner since the data associated with the data packet 106 is lost.

One problem with conventional data accessing approaches is that buffer 208 has to be constantly checked to determine whether data is available for processing. This is an inefficient approach that wastes processing time. Another problem is that there is no mechanism to notify the receiver of loss of data, for example, as a result of buffer overwrite, due to a high transmission rate. Yet another problem is that when a receiver falls behind in processing synchronized data, there is no mechanism to allow the receiver to resynchronize with the broadcast transmission.

In view of the foregoing, there is a need for improved methods and apparatus for keeping track of and accessing synchronized data transmitted by a broadcaster.

## SUMMARY OF THE INVENTION

Broadly speaking, the invention relates to methods and apparatus for accessing data that is transmitted by a broadcaster. In accordance with one aspect of the invention, a receiver capable of accessing selected portions of synchronized data that is transmitted by a broadcaster in a broadcasting system, the receiver includes a synchronized data accessing system capable of providing access to synchronized data transmitted by the broadcaster, the synchronized data accessing system providing an interface that can be used by a data requester to access synchronized data, wherein the data requester can initiate a request to access synchronized data using the interface and data can be made available and accessed by the data requester through the interface.

In accordance with another embodiment, a method of accessing synchronized data transmitted by a broadcaster in a broadcast system is disclosed. The method includes acquiring a listener interface, the listener interface providing an interface for a data requester to request access to synchronized data. The method further includes acquiring a point of access interface, the point of access interface allowing the listener to access synchronized data. In addition, the listener interface is linked to the point of access interface, as well as accessing synchronized data through the listener interface via the point of access interface.

The invention can be implemented in numerous ways, including as a computer system, an apparatus, and a method. Several embodiments of the invention are discussed below.

Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein  
5 like reference numerals designate like structural elements, and in which:

Fig. 1 illustrates conventional synchronized data packets transmitted by a T.V. broadcaster.

Fig. 2 illustrates a conventional digital T.V. receiver.

Fig. 3 illustrates a receiver suitable for reception of synchronized data, in  
10 accordance with an embodiment of the present invention.

Fig. 4 illustrates a receiver suitable for reception of synchronized data, in accordance with an embodiment of the present invention.

Fig. 5 illustrates a method of accessing synchronized data in a broadcast system, in accordance with a particular embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

The invention relates to methods, apparatus, and data structures suitable for accessing synchronized data in a broadcast system. In accordance with one aspect of the invention, a receiver capable of receiving synchronized data transmitted by a broadcaster is disclosed.

Fig. 3 illustrates a receiver 300 suitable for accessing synchronized data transmitted by a broadcaster, in accordance with an embodiment of the present invention. It should be noted that the receiver 300 can be any device suitable for reception of broadcast data, e.g., a digital T.V., set-top box, analog T.V. coupled to a set-top box, as well as a computer (a lap top computer, etc.) For example, the receiver can be a digital T.V. or a set-top box running an interactive program where the receiver is implemented as a virtual machine supporting an open interface, e.g., Java, Java T.V., etc.

The receiver 300 includes a synchronized data accessing system 302 suitable for providing efficient access to synchronized data transmitted by a broadcaster. As illustrated in Fig. 3, the synchronized data accessing system 302 includes a synchronized data accessor 304 and a synchronized data provider 306. The synchronized data accessor 304 can receive a request 308 for accessing synchronized data transmitted on a particular broadcast service, e.g., a channel or subchannel. By way of example, the request 308 can be initiated by an application program that requires access to synchronized data transmitted on a particular channel.

The synchronized data accessor 304 can, in turn, request the synchronized data from the synchronized data provider 306. When synchronized data is transmitted and received, the synchronized data provider 306 can store it in a data storage buffer 310. After synchronized data is received, the synchronized data provider 306 notifies the synchronized data accessor 304 that data is available for access. In this way, synchronized data accessor 304 does not have to check for the arrival of data, thereby freeing the synchronized data accessor 304 to receive and initiate additional requests for access to synchronized data.

In the described embodiment, when a data arrival notification is received, the synchronized data accessor 304 notifies the original data requester( that can be, for example, an application program) that data is available for access. In this manner, a notification can be provided when data is ready for access so that an application program does not waste processing time determining whether data has arrived. Thus, an application program can efficiently access data and devote more time to other tasks.

In accordance with a particular embodiment of the invention using the data arrival notification, synchronized data provider 306 provides information including the time stamp and length of synchronized data that is available to be accessed. By providing information about the synchronized data that has been received, more flexibility in data access can be achieved. In addition, the information about synchronized data can be used to make more efficient data accessing decisions.

Furthermore, in case when data is unavailable, the synchronized data provider 306 can send an error notification to the data accessor 304. This error notification can be sent to a data requester (an application program, for example) so that the error can be handled accordingly. In accordance with one particular embodiment, synchronized data accessor 304 can also send a request to resynchronize data access. For example, the synchronized data provider 306 can be asked to send notification of the last synchronized data packet received. Advantageously, this enables a data requester to resynchronize with the broadcast transmission.

Although the synchronized data provider 306 is depicted to include a data storage buffer 310, it should be noted that data storage buffer 310 can reside outside of the synchronized data provider 306 without departing from the scope and spirit of the invention. It should also be noted that besides a data storage device, other suitable mechanisms to store and pass data to synchronized data accessor 304 may be implemented.

Fig 4 illustrates a receiver 400 suitable for reception and processing of synchronized data, in accordance with another embodiment of the present



invention. The receiver 400 includes the synchronized data accessor 304 and the synchronized data provider 306. As shown, an application program 402 is running on the receiver 400. By way of example, the application program 402 can be an interactive application program or applet. The application program  
5 402 requires access to synchronized data that is transmitted by a broadcaster on a particular channel and received via a data subchannel (Da or Db). Synchronized data can then be provided to the application program 402 for synchronized processing of data for applications, such as interactive T.V. or other such arrangements.

10 In one embodiment, the synchronized data accessor 304 is implemented as an application programming interface (API). The API provides a listener interface that can be used to efficiently access synchronized data. The application program 402 can use the API to initiate one or more listeners, such as listeners 404 and 408. A listener, such as listener 404, can be used to provide  
15 access to synchronized data transmitted on a particular broadcast channel via a data subchannel, e.g., Da.

In addition to listeners, one or more points of access can be initiated and used to provide synchronized data access to the application program through a listener. Points of access 410-420 can be provided by synchronized data  
20 provider 306. In this embodiment, synchronized data provider 306 is implemented as a part of system software and is capable of providing a point of access for a listener.

A point of access, such as the point of access 410, can be designated and linked to a listener 404, thereby allowing the listener interface 404 to access  
25 synchronized data via the point of access 410. When synchronized data is received, it can be provided to the synchronized data provider 306. In one embodiment, synchronized data provider 306 can store synchronized data packets and make them available for access upon request. For example, synchronized data requested by listener 404 is maintained in data storage 422,  
30 and synchronized data requested by listener 408 is maintained in data storage 424, and so forth.

Advantageously, upon arrival of data, synchronized data provider 306 sends a notification to the appropriate listener. For example, when synchronized data packet 102 is received, a notification is sent to listener 404. In accordance with one embodiment of the present invention, the notification can include  
5 information such as the time stamp T1 and length of synchronized data D1. The synchronized data accessor 304 can, in turn, notify the application program 402 that synchronized data has been received and is available for access through the data provider.

In addition, other information, such as the time stamp T1 and the length  
10 of synchronized data D1, can be provided in the notification sent to the application program 402. This allows the application program 402 to take appropriate action based on the information that is provided by the synchronized data accessor 304. For example, the application program 402 can initiate a data access through the synchronized data accessor 304 by identifying a desired point  
15 of access. The application program 402 can choose to ignore a data arrival notification for a listener but initiate a data access request for data notified through another listener.

In accordance with one embodiment, the application program 402 can choose to access a portion of available data by providing an offset and the length  
20 of data to be accessed. In this manner, application program 402 has the flexibility to access data in segments and/or choose to ignore a portion of data available in a synchronized data packet.

Furthermore, if application program 402 initiates access for data that is no longer available in the data storage 422, an error notification can be sent to the  
25 application program 402 so that appropriate error handling actions can be taken. For example, if synchronized data packet 102 is no longer available for access, perhaps due to a buffer overfill, an error notification can be sent to the application program 402.

In one embodiment, the application program can resynchronize with the  
30 broadcast transmission by sending a request to be notified of the last data available for access on a particular listener. For example, if application program 402 falls behind in processing synchronized data, it can send a request to

receive notification of the last synchronized data packet received. The synchronized data provider 306 can allow access to the last synchronized data packet 106 received and continue sending notifications when the next synchronized data packet is available for access. In this way, the application  
5 program 402 can resynchronize with the broadcast transmission.

Fig. 5 shows a flowchart detailing a method 500 of accessing synchronized data transmitted in a broadcast system in accordance with an embodiment of the present invention. In operation, at 502, a listener interface is acquired. In one embodiment, the listener interface is implemented as an  
10 interface in an object programming language such as C++ , Java, etc. For example, in one particular embodiment, the listener interface is implemented as a Java public abstract interface as an interface for providing notification of pending synchronized data that is available for access.

Next, at operation 504, a point of access is acquired. In one  
15 embodiment, this point of access is an access interface defined in an object programming language such as C++ , Java, etc. For example, in one particular embodiment, this access interface is a Java public abstract interface that can be provided as an access object to a listener.

The acquired listener interface is linked to the point of access, as noted at  
20 506. In one particular embodiment, this linking operation is implemented as a Java method that registers the listener interface with the point of access interface to provide the listener with notification indicating the availability of data for access from the point of access.

Next, at 508, synchronized data is received and is available for access  
25 from the point of access interface. Upon arrival of synchronized data, a notification is sent to the appropriate listener to indicate availability of data, as noted in operation 510. The notification is sent to notify the listener that data can be transferred from the point of access. In one particular embodiment, this notification is implemented as a Java method for reception of a Java event that  
30 provides information such as the time stamp and length of a synchronized data packet that is available for access.

Finally, synchronized data is accessed through the point of access at 512. Synchronized data can be provided via the point of access and made available for access through the listener interface. In one embodiment, data access can be achieved as a read operation of an object programming language, for example, a  
5 Java read method.

Method 500 can be used by an application program or applet running on an operating system. An application program or applet can interface with a Virtual Machine running a Real-Time Operating System. In one embodiment, the application program or applet uses a Java T.V. Application Programming  
10 Interface (API) to access synchronized data transmitted by a broadcaster. The JAVA TV API is an extension of the JAVA platform developed by Sun Microsystems of Mountain View, CA.

Although only a few embodiments of the present invention have been described, it should be understood that the present invention may be embodied  
15 in many other specific forms without departing from the spirit or scope of the invention. By way of example, although method 500 has been set forth in terms of a particular sequential order for the purposes of this explanation, it should be apparent that in many cases the ordering is not critical. Some operations may be combined or eliminated and others may be parsed into multiple operations. For  
20 example, operation 512 can be implemented as a series of multiple access operations or may be eliminated since, in some cases, access to synchronized data may not be desired. The same functionality can also be obtained using different operations as well.

The invention has numerous advantages. One advantage is that data  
25 arrival notification can be provided to allow efficient access of synchronized data. Another advantage is that error notifications can be sent to allow appropriate error handling actions to be taken. Yet another advantage is that synchronized data can be accessed based on information, such as time stamp and length of synchronized data. Still another advantage is that cost effective  
30 and efficient solutions can be implemented to access synchronized data.

The many features and advantages of the present invention are apparent from the written description, and thus, it is intended by the appended claims to cover all such features and advantages of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not  
5 desired to limit the invention to the exact construction and operation as illustrated and described. Hence, all suitable modifications and equivalents may be resorted to as falling within the scope of the invention.

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*What is claimed is:*